AN EFFICIENT VLSI IMPLEMENTATION OF EDGE DETECTION ALGORITHM FOR IMAGE PROCESSING APPLICATION

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ABSTRACT : *Edge detection is that the core research area among different fields such as; image processing. Computer vision, machine learning, pattern recognition. In object detection, the primary obligatory step is to work out the perimeters of an object during a better way that's further used for processing. The feature vector comprises nothing but key point description, which provides the data of edges. Edge detection is that the key to success and is somehow or the opposite passionate about it. The proposed Sobel edge detection algorithm uses approximation methods to interchange the complex operations; pipelining is used to cut back the latency. Finally, this algorithm is implemented by Verilog HDL. The mix is formed with Prewitt and Laplacian algorithm as one architecture by similar methodology compared with the previous hardware architecture for edge detection, the proposed architecture requires fewer Area, Delay & Power Efficient.*

Key Words: **Sobel, Prewitt, Laplacian, Pixel range, Area, Time delay, ADD and SHIFT algorithm**.

1. INTRODUCTION

Edge detection techniques are successfully used for various applications. In edge detection, the abrupt changes within the pixel intensity are determined. These change in pixel intensities are determined by different techniques, during which different parameters are tuned to refine the sides of salient objects while suppressing the redundant objects from image. The perimeters obtained by different edge detector are broadly classified into two types: correct edges and false edges. Correct edge represent salient object and false edges are produced thanks to detector sensitiveness. The algorithms have three steps: filtering, enhancement and detection. Filtering is often accustomed remove the noise from image. Enhancement is employed to magnify the pixel intensity values in local area of a picture and in detection the strong edges are determined. Recent research within the fields of computer science computer vision and Pattern Recognition reveals that the sting detection is extremely important in how or the opposite. Key point detection is one major a part of the method that majorly deals with image edges not only edges but also true edges. Identified key points are then accustomed describe the feature vectors that are further employed in different applications. There is much research happening nowadays jittery detection because it incorporates a key role in the majority upcoming fields.

2. RELATED WORK

The robust threshold computation method with high accuracy has been introduced, and utilizes more resources with increased computational complexity. The Sobel edge detection circuit are applied to an end-user camera equipment should have lower hardware cost. In previous implementation the lower hardware cost is achieved by employing rough calculations to switch the complicated operations and reduction in computer file to satisfy the real-time applications. However, it leads to lower accuracy. Thus, there's a trade-off between hardware cost and accuracy. Image processing has applications in embedded systems. Real time image processing requires processing on large data of image pixels in an exceedingly stipulated time. Reconfigurable devices, such as FPGAs, are often programmed to process large image data, and the time interval required for the image can be reduced by using parallelism and pipeline techniques in the algorithm.. Edge detection is extremely basic tool utilized in many image processing. Laplacian, Prewitt, Sobel edge detection are gradient based edge detection methods accustomed find edge pixels in a picture. This paper presents comparisons of Laplacian, Prewitt, Sobel operators based edge detection techniques for real time uses. Edge detection algorithms are written with the assistance of hardware descriptive language VHDL. Xilinx ISE Design Suite-13 and MATLAB software platforms are used for simulation purpose. This paper target edge detection of Gray scale image.

3. Objective of the paper:

i. To edge deduct the image using Sobel detection algorithm using binary operators.

ii. To merge Sobel with Prewitt Laplacian Edge Detection Operator as a single architecture.

iii. To improve the area and delay of the detection operator using **shift** and **add algorithm**

4. SYSTEM TECHNIQUE

Targeted edge detection with Sobel Operator in digital image processing and implementation with Verilog HDL. Firstly, a jpg image is inputted and converted into binary image with the assistance of MATLAB. Capture a jpg image that is in RGB color space by default and convert this RGB image to grayscale image. Now convert the grayscale image to binary image. This binary image is incredibly large, so it was resized and written in a document shown in Figure. Additional implementation in Xilinx ISE and Modelsim has been completed.The Sobel operator is employed commonly in edge detection. At each point in the image, the result of the Sobel operator is the corresponding norm of this gradient vector. The Sobel operator only takes into account the 2 orientations, which are nuclei of convolution of 0 ° and 90 °.

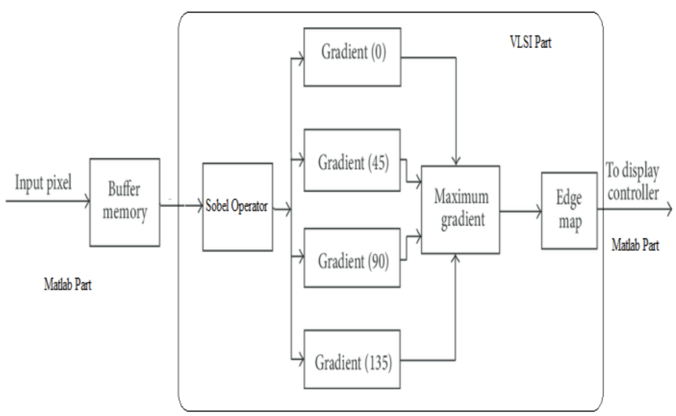

Fig 1. System flow of edge detection

The operator uses the two bent nuclei with the original image to calculate approximations of the gradient. As noted above, gradients along with size are calculated in the Verilog HDL synthesis and then simulated and verified for design summary and time analysis. Now with the help of Xilinx ISE, read the MATLAB generated text file into memory and save it to RAM, then extract the window from the image.

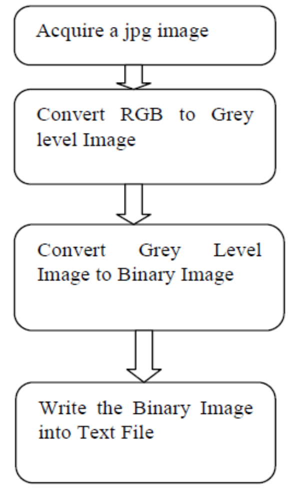

Fig 2. Process flow in MATLAB Part

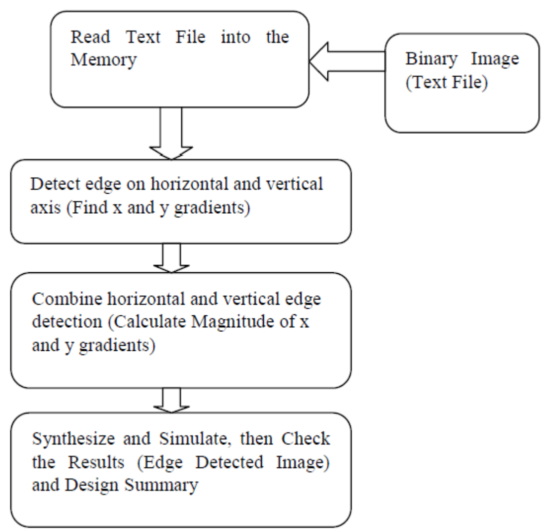

Fig 3. Process flow in VLSI Part

- Read image
- Compare gradient size with threshold and find true edges
- Apply convolution mask i and j to input image
- Find gradient size by calculating
- Compare the size of the gradient to the threshold and find the true edge.

5. EDGE DETECTION METHODOLOGY

The Sobel operator is used to detect the edges of the test images used. This method is applied to more than one test image as shown in FIG. First, the image data is read as an array with the dimension of the image size. The number of elements in this array is calculated to resize the image array to another array. The size change to use is (256 × 256) in the MATLAB program.

Fig 4 Image Read

The horizontal template and vertical template shown in Fig. 4 above are used to get convolution with input image by using equation (1) and (2).

Fig 5. Convoluted Image

The resulting matrix after this operation has the same size of two gradient matrices Gx and Gy as the original image, as shown in Fig. 5. The size of the gradient is determined by squaring the pixel values of each filtered image, then adding the two results and taking their root to obtain the total value of the gradient (Gr). Sobel Edge Location has two covers, one veil recognizes flat edges and the other cover distinguishes vertical edges. Each of the masks has the effect of calculating the gradient in both the vertical and horizontal directions. These Sobel masks fold with a smoothed image and result in gradients in the i and j directions given by Gi = Gx * F (i, j) and Gj = Gy * F (i, j) Finally , the edges can be recognized are obtained by applying the threshold through equation (5) to the total gradient (Gr). In the event that (Gr) is more noteworthy than the edge, the pixel should be distinguished as an edge as displayed in FIG. Otherwise, it will not be identified as an advantage. This edge Detection logic is made by Schostic Logic Circuit.

Fig 6. Edge Detected Image

Also, Sobel Locator: is one of the most every now and again utilized in edge recognition. Sobel edge location can be carried out by sifting a picture with left cover or piece. Channel the picture again with the other veil. After this square of the pixels upsides of each sifted picture. Presently add the two outcomes and figure their root. The 3 × 3 convolution veils for the Sobel based administrator as displayed in below Table.

G_x

-1	-2	-1
0	0	0
1	2	1

G_y

-1	0	1
-2	0	2
-1	0	1

(a) SOBEL kernel matrices

The algorithm is carried out by ADD and SHIFT operation accordingly.

Gx= ((p2-p0) + ((p5-p3)<<1) + (p8-p6))

Sobel mask for gradient in horizontal direction

Gy=((p0-p6) + ((p1-p7)<<1) + (p2-p8))

Sobel mask for gradient in vertical direction .

Accordingly PREWITT and LAPLACIAN algorithm is carried out by same ADD and SHIFT operators using the kernel matrices given below

(b) LAPLACIAN kernel matrices

0	1	0
1	-4	1
0	1	0

←(POSITIVE)

0	-1	0
-1	4	-1
0	-1	0

(NEGATIVE)→

(c) PREWITT kernel matrices

-1	0	1
-1	0	1
-1	0	1

←(VERTICAL)

(HORIZONTAL)→

1	1	1
0	0	0
-1	-1	-1

6. RESULT AND DISCUSSION

The edge detection of an image is performed in a single architecture with the combination of SOBEL, PREWITT, LAPLACIAN algorithms and its area and delay are compared accordingly.

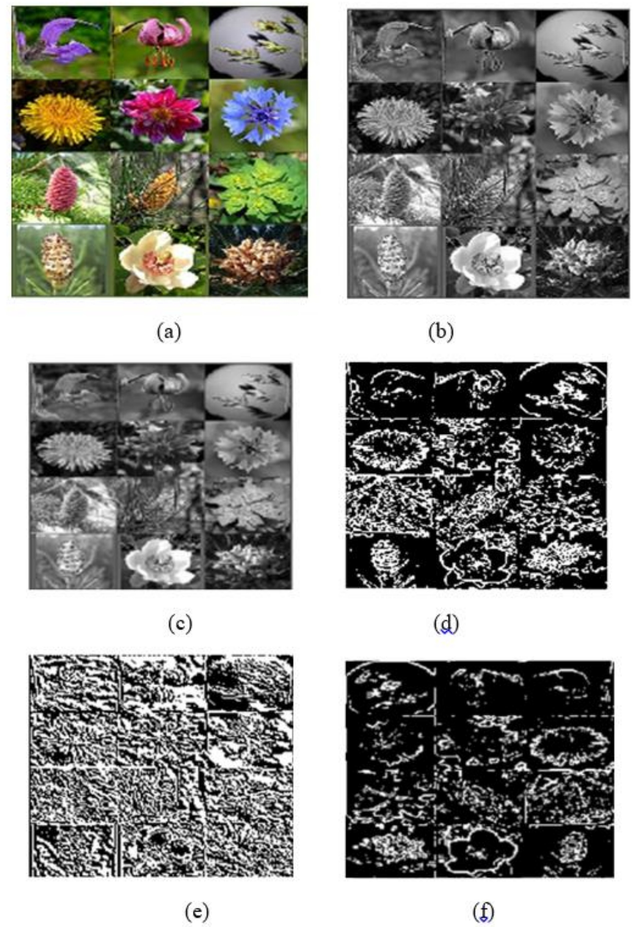

Fig 7. (a) Input image (b) Gray image

(c) Resized image (d) Sobel edge detected

(e) Laplacian edge detected

(f) Prewitt edge detected

7. SIMULATION

The simulation is carried out in Modelsim and the scale level from 0-255 can be noticed as the result of edge detection mechanism.

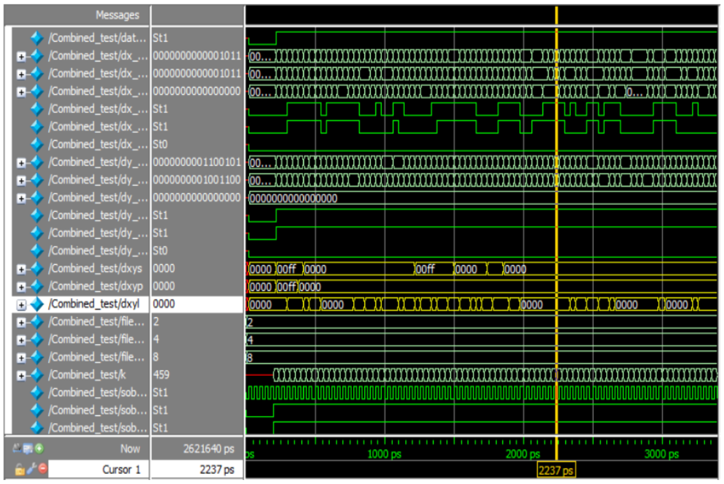

Fig 8. SIMULATION WAVEFORM

8. SYNTHESIS AND COMPARISON

Method	Area			Delay		
Spartan 3	LUT	Slices	Gates	Overall Delay	Gate Delay	Path Delay
Proposed	302	156	3705	30.745 ns	18.485ns	12.260 ns
Modification	119	77	1736	28.121 ns	15.304ns	12.817 ns

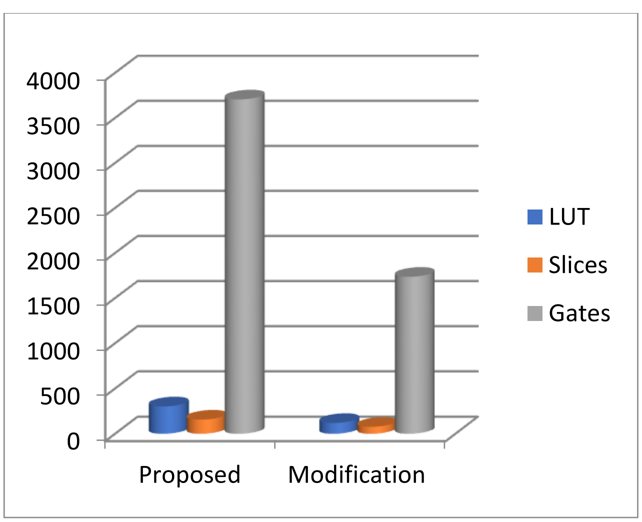

Fig 9. AREA COMPARISON

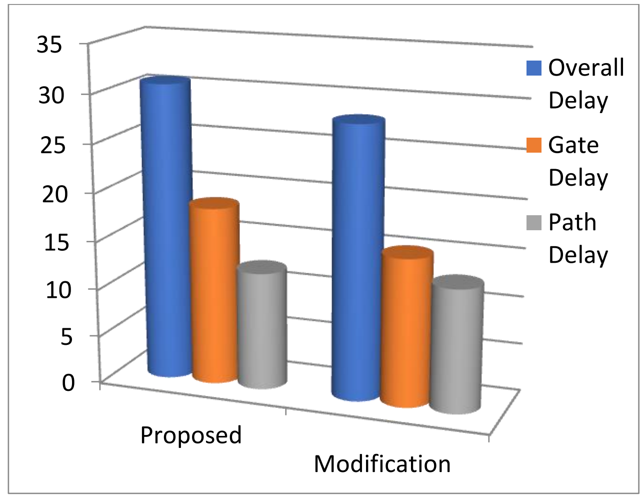

Fig 10. DELAY COMPARISON

9. CONCLUSION

This paper mainly focuses on the design and simulation System of the Sobel edge detection method. This method uses two 3×3 convolution masks to estimate gradient in X and Y-direction and which is easy to implement than other operators. The Sobel edge detection method calculates 2-D spatial gradient of image intensity at each point of an image by convolution with small and integer valued filters therefore relatively less expensive in terms of computations. Application of Sobel edge detection algorithm to an image may considerably decrease the amount of details to be processed and with pulse width modulation, time-encoded signals corresponding to specific values are generated by adjusting the frequency and duty cycles of signals. Thereby Sobel is combined with Laplacian and Prewitt algorithm as a single architecture with this approach, the latency, area consumption is all greatly reduced.

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